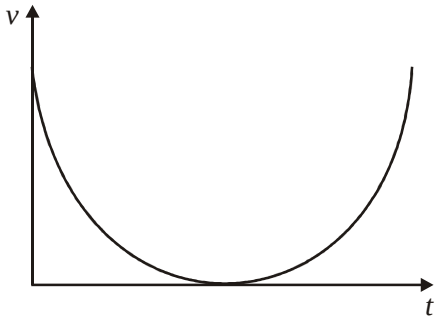
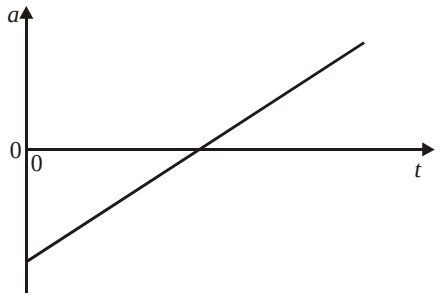
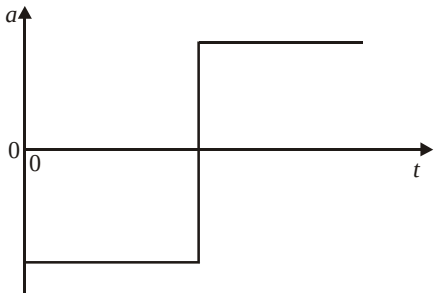
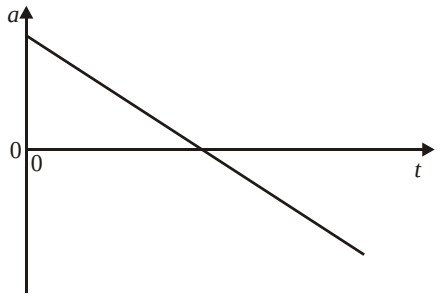
1. The graph shows the variation with time *t* of the velocity *v* of an object.

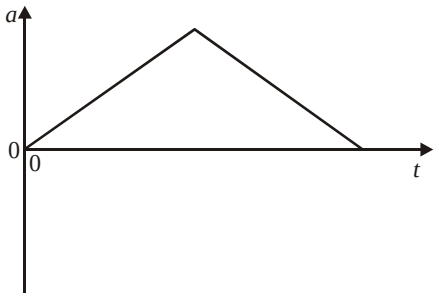


Which **one** of the following graphs best represents the variation with time *t* of the acceleration *a* of the object?

A.


B.


C.


D.


(1)

2. A ball, initially at rest, takes time *t* to fall through a vertical distance *h*. If air resistance is ignored, the time taken for the ball to fall from rest through a vertical distance *9h* is

A. *3t*.

B. *5t*.

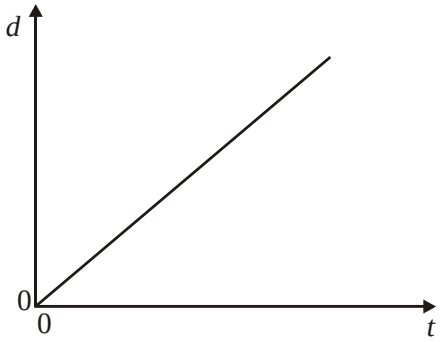
C. *9t*.

D. 10*t*.

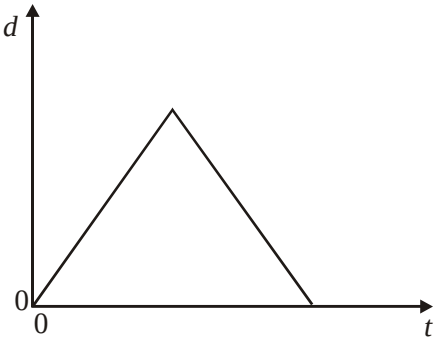
(1)

3. An athlete runs round a circular track at constant speed. Which **one** of the following graphs best represents the variation with time *t* of the magnitude *d* of the **displacement** of the athlete from the starting position during one lap of the track?

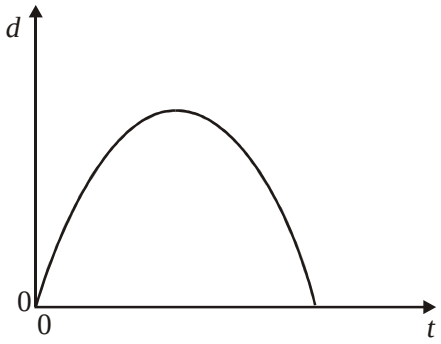
A.



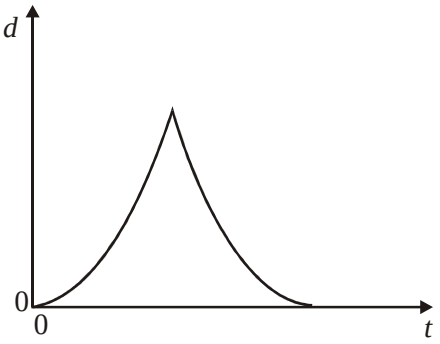
B.



C.



D.



(1)

4. A ball is released from rest near the surface of the Moon. Which **one** of the following quantities increases at a constant rate?

A. Only distance fallen

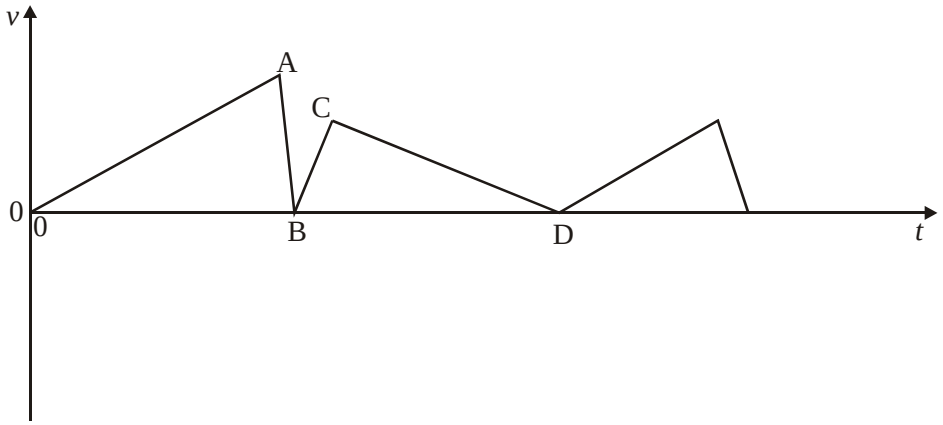
B. Only speed

C. Only speed and distance fallen

D. Only speed and acceleration

(1)

5. A ball is dropped from rest at time $t = 0$ on to a horizontal surface from which it rebounds. The graph shows the variation of time t with **speed** v of the ball.



Which **one** of the following best represents the point at which the ball just loses contact with the surface after the first bounce?

A. A

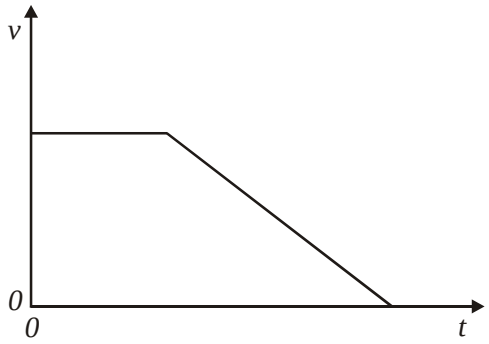
B. B

C. C

D. D

(1)

6. The diagram below shows the variation with time t of the velocity v of an object.



The area between the line of the graph and the time-axis represents

A. the average velocity of the object.

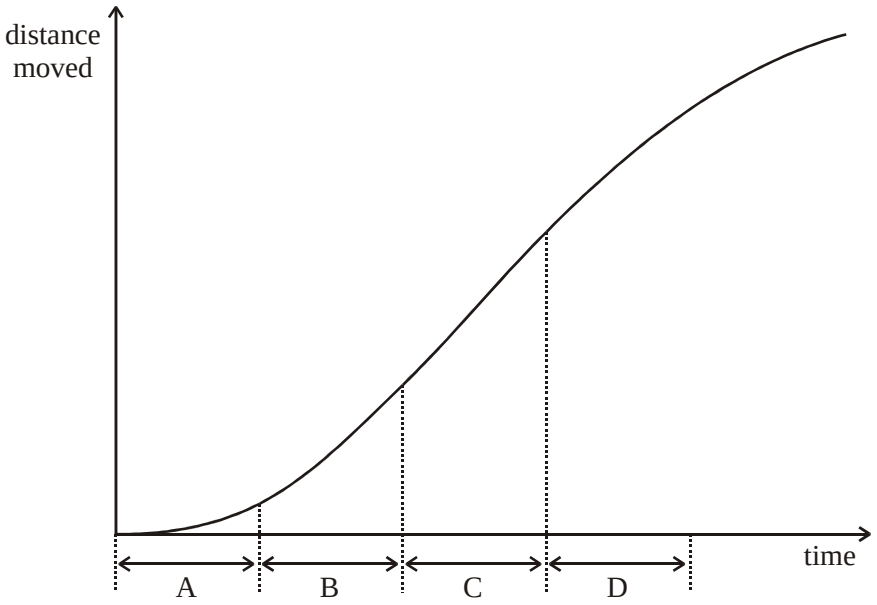
B. the displacement of the object.

C. the impulse acting on the object.

D. the work done on the object.

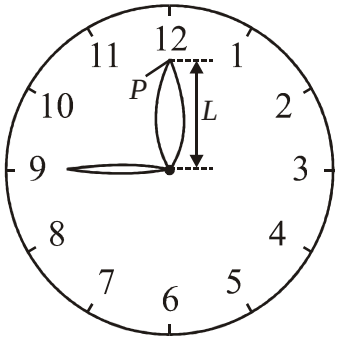
(1)

7. The graph below shows the variation with time of the distance moved by a car along a straight road. During which time interval does the car have its greatest acceleration?



(1)

8. The minute hand of a clock hung on a vertical wall has length *L*.



The minute hand is observed at the time shown above and then again, 30 minutes later.

What is the displacement of, and the distance moved by, the end P of the minute hand during this time interval?

	displacement	**distance moved**
A.	2*L* vertically downwards	π*L*
B.	2*L* vertically upwards	π*L*
C.	2*L* vertically downwards	2*L*
D.	2*L* vertically upwards	2*L*

(1)

9. Which **one** of the following is a correct definition of *displacement*?

A. Distance from a fixed point

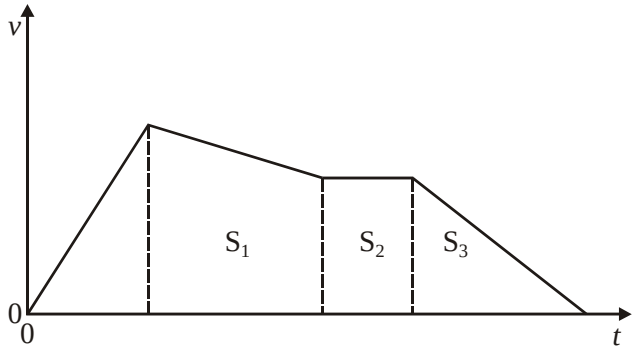
B. Distance moved from a fixed point

C. Distance from a fixed point in a given direction

D. Distance moved in a given direction

(1)

10. The variation with time *t* of the speed *v* of a car moving along a straight road is shown below.



Which area, S_1, S_2 or S_3, or combination of areas, represents the total distance moved by the car during the time that its speed is reducing?

A. S_1

B. S_3

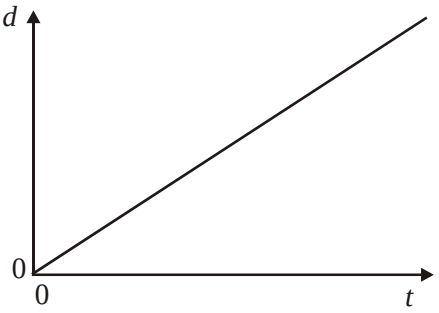
C. $S_1 + S_3$

D. $S_1 + S_2 + S_3$

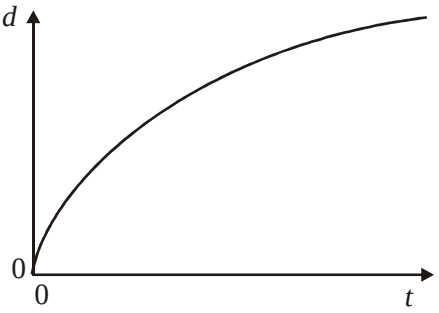
(1)

11. A ball is held at rest in air. The ball is then released. Which **one** of the following graphs best shows the variation with time *t* of the distance *d* fallen by the ball?

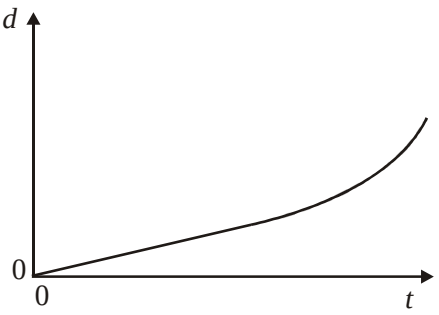
A.



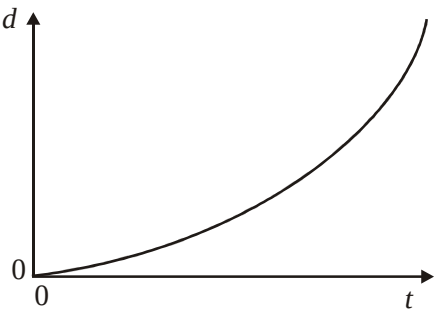
B.



C.



D.

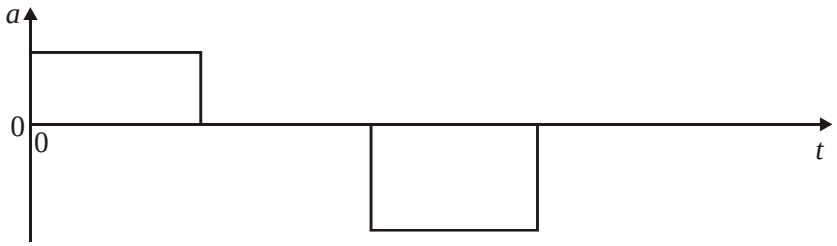


(1)

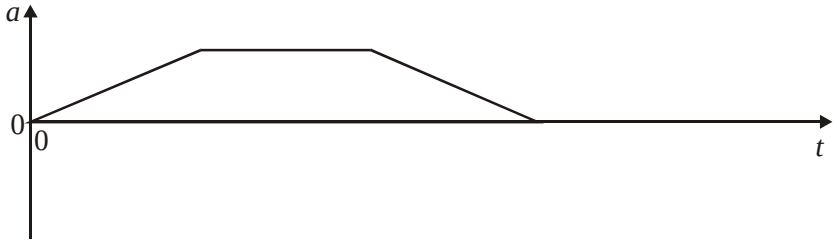
12. A car accelerates uniformly from rest. It then continues at constant speed before the brakes are applied, bringing the car to rest.

Which of the following graphs best shows the variation with time *t* of the **acceleration** *a* of the car?

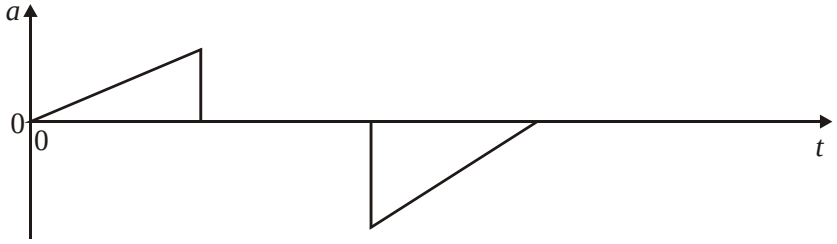
A.



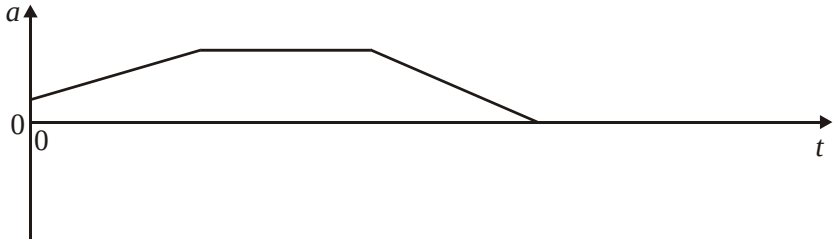
B.



C.

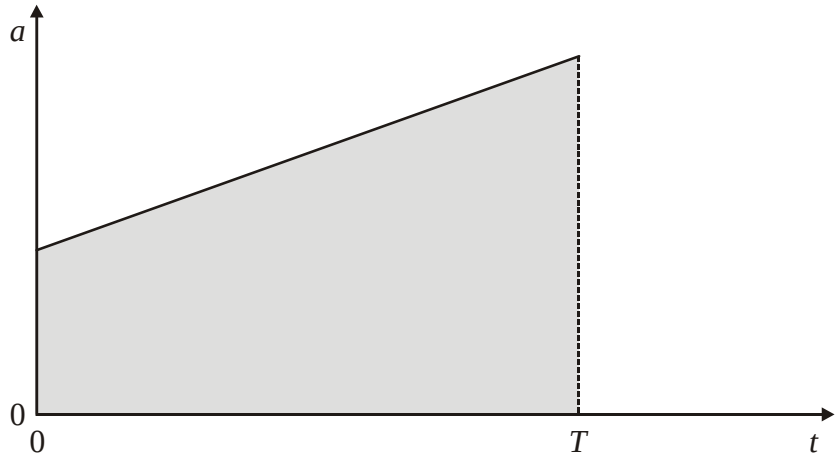


D.



(1)

13. The graph below shows the variation with time t of the acceleration a of a spaceship.



The spaceship is at rest at $t = 0$.

The shaded area represents

A. the distance travelled by the spaceship between $t = 0$ and $t = T$.

B. the speed of the spaceship at $t = T$.

C. the rate at which the speed of the spaceship changes between $t = 0$ and $t = T$.

D. the rate at which the acceleration changes between $t = 0$ and $t = T$.

(1)

14. A particle moves from a point P to a point Q in a time T. Which **one** of the following correctly defines both the average velocity and average acceleration of the particle?

	Average velocity	**Average acceleration**
A.	$\frac{\text{displacement of Q and P}}{T}$	$\frac{\text{change in speed from Q to P}}{T}$
B.	$\frac{\text{displacement of Q and P}}{T}$	$\frac{\text{change in velocity from Q to P}}{T}$
C.	$\frac{\text{distance between Q and P}}{T}$	$\frac{\text{change in speed from Q to P}}{T}$
D.	$\frac{\text{distance between Q and P}}{T}$	$\frac{\text{change in velocity from Q to P}}{T}$

(1)

15. Two stones, X and Y, of different mass are dropped from the top of a cliff. Stone Y is dropped a short time after stone X. Air resistance is negligible.

Whilst the stones are falling, the distance between them will

A. decrease if the mass of Y is greater than the mass of X.

B. increase if the mass of X is greater than the mass of Y.

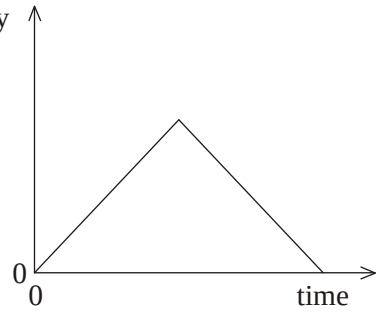
C. decrease whether the mass of X is greater or less than the mass of Y.

D. increase whether the mass of X is greater or less than the mass of Y.

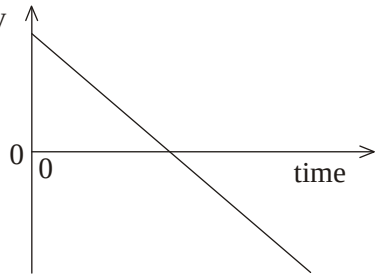
(1)

16. An archer shoots an arrow at an angle to the horizontal. Air resistance is negligible. Which of the following graphs best represents the variation with time of the **horizontal component** of the arrow's velocity from the time it is launched to the time just before it hits the ground?

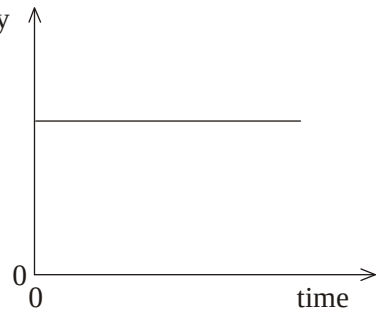
A.



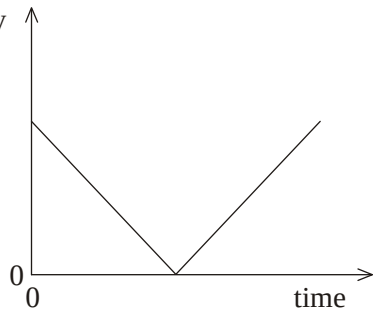
B.



C.

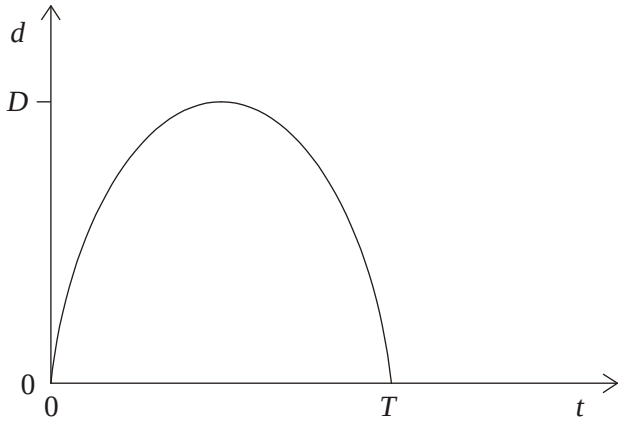


D.



(1)

17. A ball is thrown vertically upwards from the ground. The graph shows the variation with time t of the vertical displacement d of the ball.

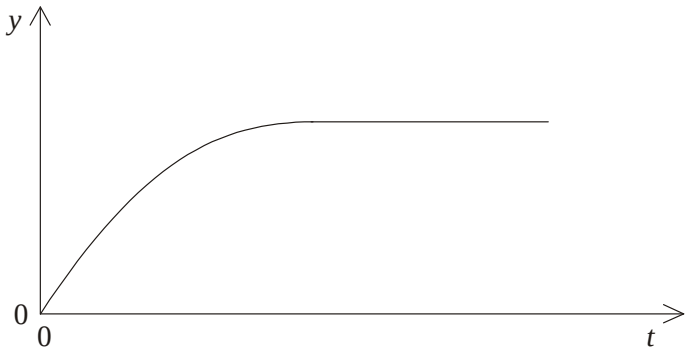


Which **one** of the following gives the final displacement after time T and the average speed between time $t = 0$ and time $t = T$?

	Displacement	**Average speed**
A.	0	0
B.	0	$\frac{2D}{T}$
C.	$2D$	$\frac{2D}{T}$
D.	$2D$	0

(1)

18. The graph below shows how a quantity *y* varies with time *t* for a falling object.



Which **one** of the following quantities could be represented by *y*?

A. Speed when air resistance is negligible

B. Speed when air resistance is not negligible

C. Distance moved from rest when air resistance is negligible

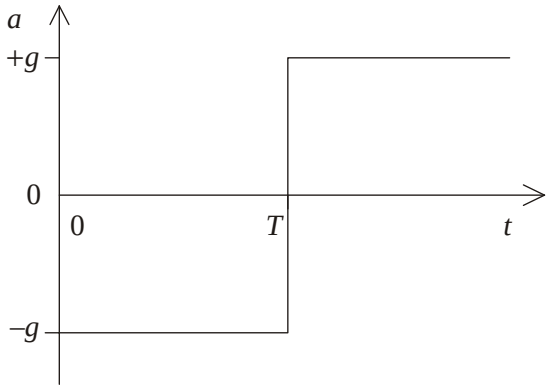
D. Distance moved from rest when air resistance is not negligible

(1)

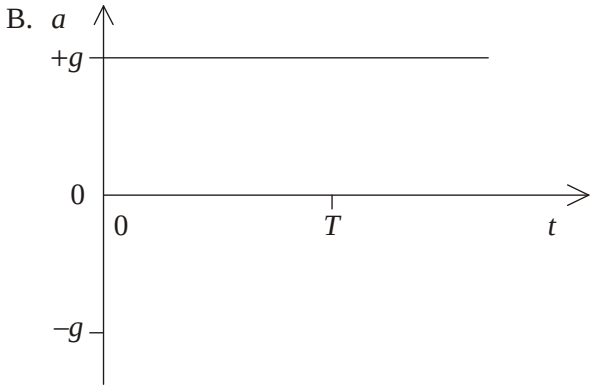
19. A ball is thrown vertically upwards at time $t = 0$. Air resistance is **not** negligible and the acceleration of free fall is g. The ball reaches a maximum height at time $t = T$ and then descends, reaching a terminal speed.

Which graph best shows the variation with time t of the acceleration a of the ball?

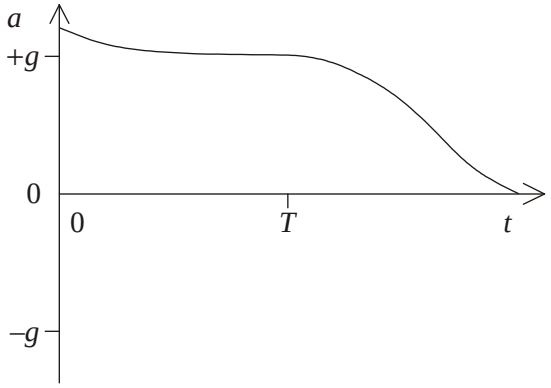
A.



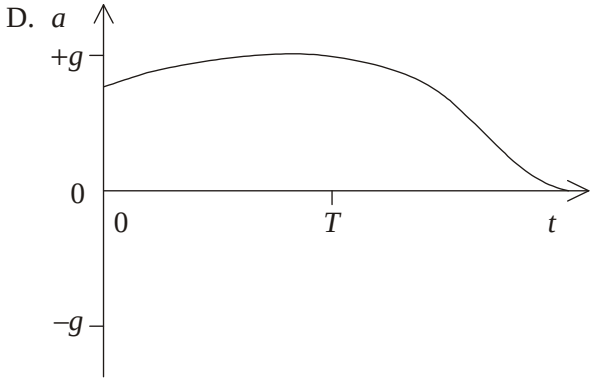
B.



C.



D.



(1)

20. A body starting from rest moves along a straight-line under the action of a constant force. After travelling a distance *d* the speed of the body is *v*.

The speed of the body when it has travelled a distance $\frac{d}{2}$ from its initial position is

A. $\frac{v}{4}$.

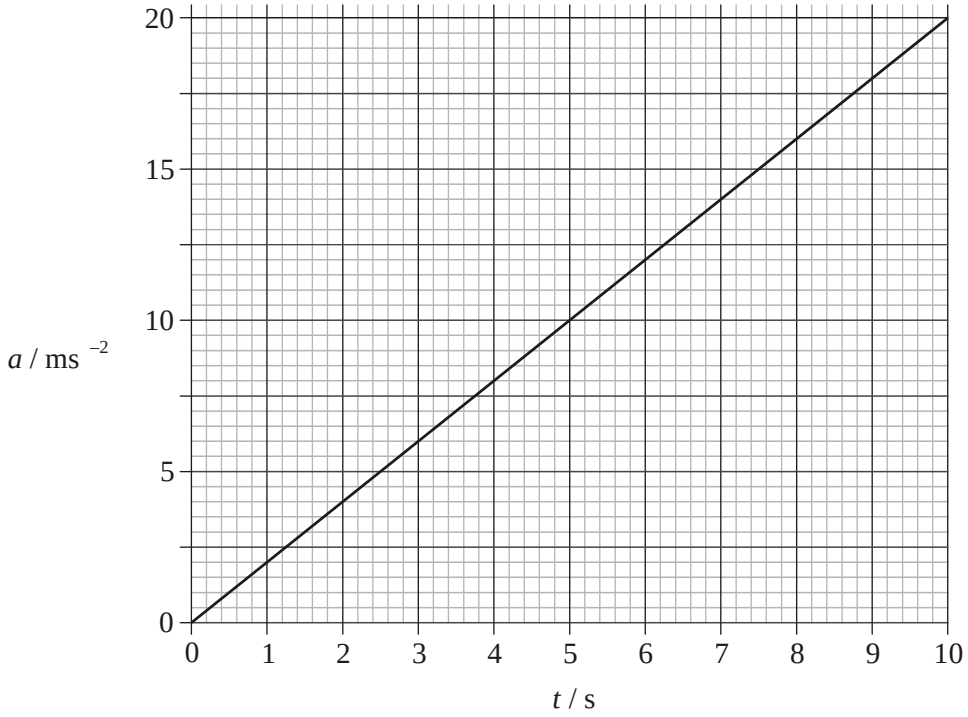
B. $\frac{v}{2}$.

C. $\frac{v}{\sqrt{2}}$.

D. $\frac{v}{2\sqrt{2}}$.

(1)

21. The graph shows the variation with time t of the acceleration a of an object.



The object is at rest at time $t = 0$.

Which of the following is the velocity of the object at time $t = 6.0$ s?

A. 0.50 m s^{-1}.

B. 2.0 m s^{-1}.

C. 36 m s^{-1}.

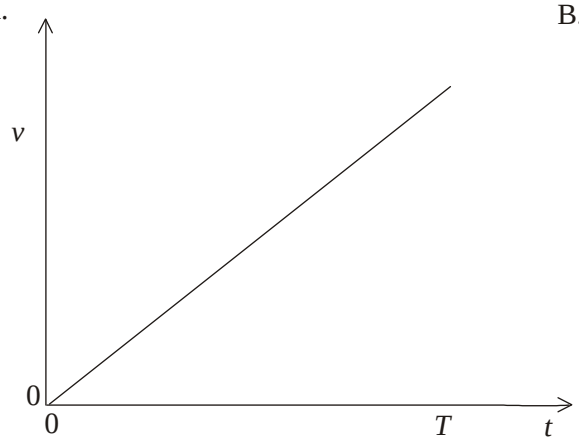
D. 72 m s^{-1}.

(1)

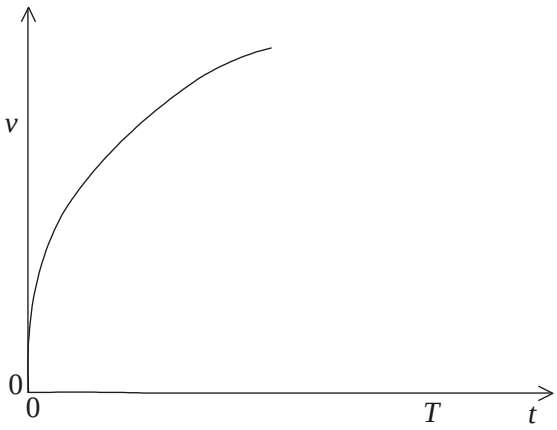
22. An object is dropped from rest from a point several hundred metres above the surface of the Earth at time $t = 0$. The object strikes the ground at $t = T$ and air resistance is **not** negligible.

Which of the following sketch graphs best shows the variation with time t, of the speed v of the object?

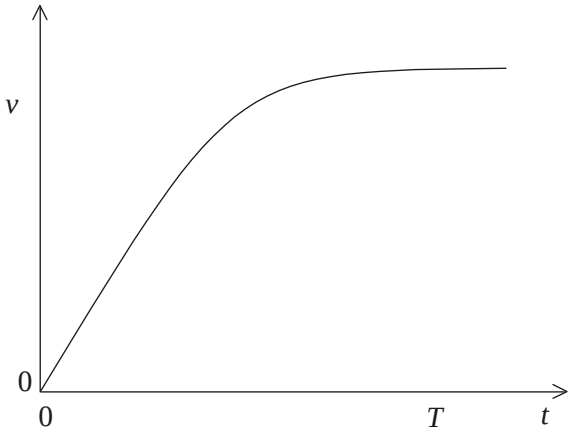
A.



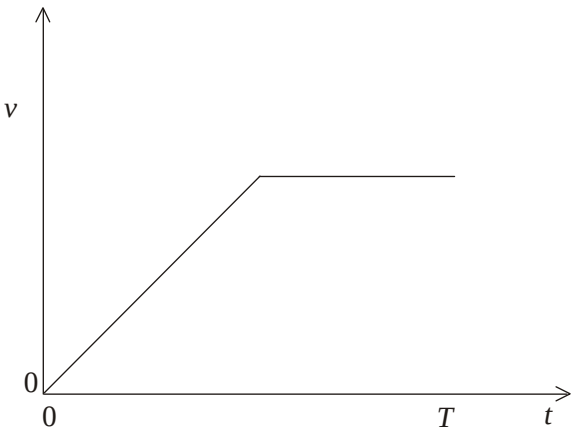
B.



C.



D.



(1)

23. Which of the following is a correct definition of average acceleration?

A. $\frac{\text{change in velocity}}{\text{time taken}}$

B. $\frac{\text{velocity}}{\text{time taken}}$

C. $\frac{\text{change in speed}}{\text{time taken}}$

D. $\frac{\text{speed}}{\text{time taken}}$

(1)

24. An object has initial speed u and acceleration a. After travelling a distance s, its final speed is v. The quantities u, v, a and s are related by the expression

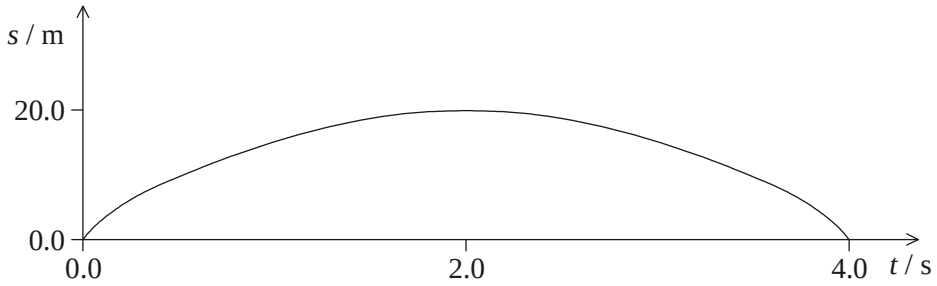
$$v^2 = u^2 + 2as.$$

Which of the following includes the **two** conditions necessary for the equation to apply?

A.	a has constant direction	u and v are in the same direction
B.	a has constant direction	a, u and v are in the same direction
C.	a has constant magnitude	a has constant direction
D.	a has constant magnitude	u and v are in the same direction

(1)

25. The graph below shows the variation with time *t* of the displacement *s* of an object moving along a straight-line.



The best estimate of the instantaneous speed of the object at t = 2.0 s is

A. 0.0 ms^{-1}.

B. 0.2 ms^{-1}.

C. 5.0 ms^{-1}.

D. 10.0 ms^{-1}.

(1)

26. A small steel ball falls from rest through a distance of 3 m. When calculating the time of fall, air resistance can be ignored because

A. air is less dense than steel.

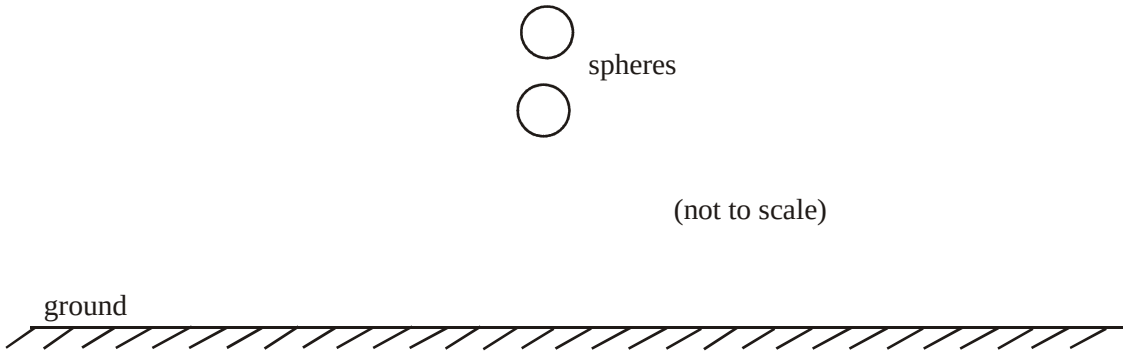
B. air resistance increases with the speed of the ball.

C. the air is not moving.

D. air resistance is much less than the weight of the ball.

(1)

27. Two identical metal spheres are held above the ground as shown.



The separation between them is small compared to their distance above the ground. When the spheres are released, the separation of the spheres will

A. remain constant.

B. decrease continuously.

C. increase continuously.

D. increase initially and then remain constant.

(1)

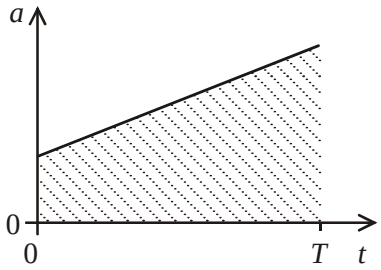
28. An object is falling, in air, towards the Earth's surface.

What changes occur in the acceleration and in the velocity of the object as it approaches terminal velocity?

	acceleration	**velocity**
A.	decreases to zero	increases continuously
B.	decreases to zero	increases to a constant value
C.	constant	increases to a constant value
D.	constant	increases continuously

(1)

29. The graph below shows the variation with time t of the acceleration a of an object from $t = 0$ to $t = T$.



The shaded area under the graph represents change in

A. displacement.

B. velocity.

C. momentum.

D. kinetic energy.

(1)

30. This question is about linear motion.

A police car P is stationary by the side of a road. A car S, exceeding the speed limit, passes the police car P at a constant speed of 18 m s^{-1}. The police car P sets off to catch car S just as car S passes the police car P. Car P accelerates at 4.5 m s^{-2} for a time of 6.0 s and then continues at constant speed. Car P takes a time *t* seconds to draw level with car S.

(a) (i) State an expression, in terms of *t*, for the distance car S travels in *t* seconds.

.....

(1)

(ii) Calculate the distance travelled by the police car P during the first 6.0 seconds of its motion.

.....

.....

(1)

(iii) Calculate the speed of the police car P after it has completed its acceleration.

.....

.....

(1)

(iv) State an expression, in terms of t, for the distance travelled by the police car P during the time that it is travelling at constant speed.

.....

(1)

(b) Using your answers to (a), determine the total time *t* taken for the police car P to draw level with car S.

.....

.....

.....

(2)
(Total 6 marks)

31. Linear motion

(a) Define the term *acceleration*.

.....

.....

(2)

(b) An object has an initial speed u and an acceleration a. After time t, its speed is v and it has moved through a distance s.

The motion of the object may be summarized by the equations

$$v = u + at,$$

$$s = \tfrac{1}{2}(v+u)t.$$

(i) State the assumption made in these equations about the acceleration a.

.....

(1)

(ii) Derive, using these equations, an expression for v in terms of u, s and a.

.....

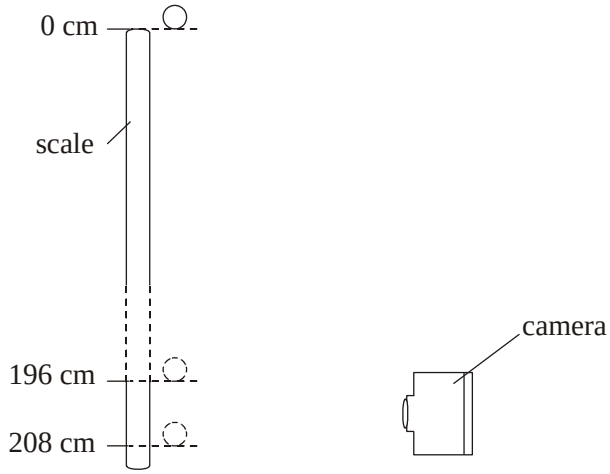
.....

.....

.....

(2)

(c) The shutter speed of a camera is the time that the film is exposed to light. In order to determine the shutter speed of a camera, a metal ball is held at rest at the zero mark of a vertical scale, as shown below. The ball is released. The shutter of a camera is opened as the ball falls.



The photograph of the ball shows that the shutter opened as the ball reached the 196 cm mark on the scale and closed as it reached the 208 cm mark. Air resistance is negligible and the acceleration of free fall is 9.81 m s^{-2}.

(i) Calculate the time for the ball to fall from rest to the 196 cm mark.

.....

.....

.....

(2)

(ii) Determine the time for which the shutter was open. That is, the time for the ball to fall from the 196 cm mark to the 208 cm mark.

.....

.....

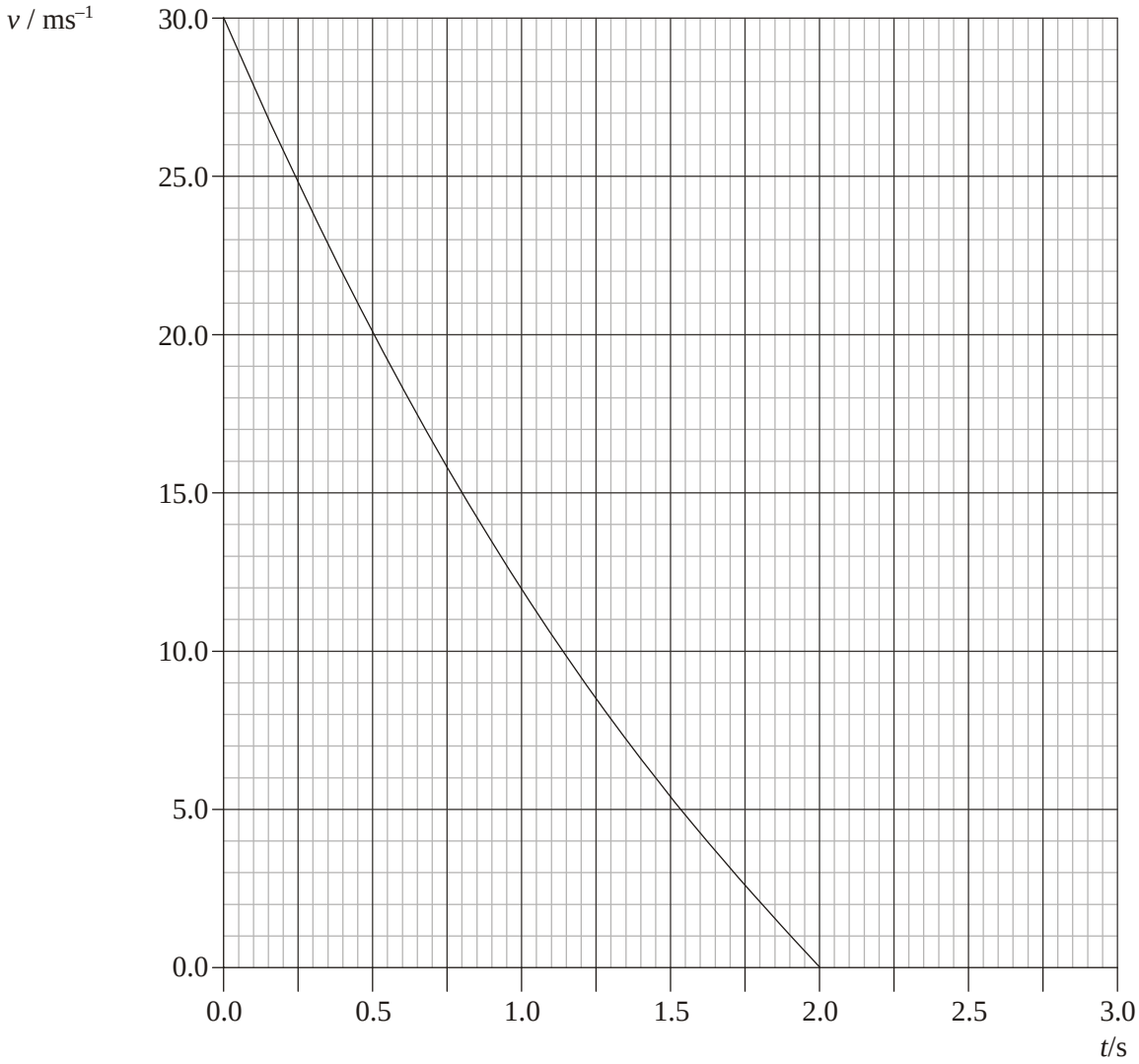
.....

(2)
(Total 9 marks)

32. Motion of a ball

A ball of mass 0.25 kg is projected vertically upwards from the ground with an initial velocity of 30 m s^{-1}. The acceleration of free fall is 10 m s^{-2}, but air resistance **cannot** be neglected.

The graph below shows the variation with time *t* of the velocity *v* of this ball for the upward part of the motion.



(a) State what the area under the graph represents.

.....

(1)

(b) Estimate the maximum height reached by the ball.

.....

.....

(1)

(c) Determine, for the ball at $t = 1.0$ s,

(i) the acceleration;

.....

.....

.....

.....

(3)

(ii) the magnitude of the force of air resistance.

.....

.....

.....

(2)

(d) Use the graph to explain, without any further calculations, that the force of air resistance is decreasing in magnitude as the ball moves upward.

.....

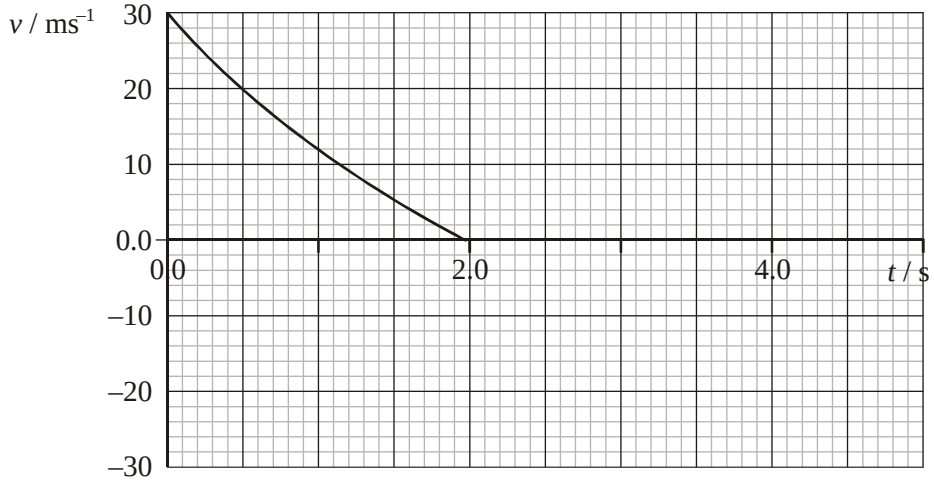
.....

.....

(2)

(e) The diagram below is a sketch graph of the upward motion of the ball.

Draw a line to indicate the downward motion of the ball. The line should indicate the motion from the maximum height of the ball until just before it hits the ground.



(2)

(f) State and explain, by reference to energy transformations, whether the speed with which the ball hits the ground is equal to 30 m s^{-1}.

.....

.....

.....

(2)

(g) Use your answer in (f) to state and explain whether the ball takes 2.0 s to move from its maximum height to the ground.

.....

.....

.....

(2)

(Total 15 marks)